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Evaluation of factors affecting mortality in cardiac arrest patients in the emergency department: A 5-year study

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Abstract
Aim: To evaluate factors affecting mortality from cardiac arrest (CA) in the emergency department (ED).
Material and Methods: Age groups, gender, location of CA, admission day, admission time, comorbidity, number of comorbidities, etiology, cardiac rhythm documented at the time of initiation of CPR (cardiopulmonary resuscitation), time interval from collapse to start of CPR, CPR duration, and mortality were evaluated.
Results: Of the 1932 patients, 1333 (69%) were male; 1582 (81.9%) patients died. Mortality in males was higher ($p<0.05$) and it was higher in patients aged 45 to 64 years and those aged 75 years ($p<0.001$). Mortality was higher in out-of-hospital CA ($p<0.001$). Mortality was high in patients who with comorbidities and those with more than 3 or 4 comorbidities ($p<0.001$). Mortality in non-cardiac CA was higher ($p<0.001$). Mortality was high in patients whose rhythms documented at the time of initiation of CPRs were pulseless electrical activity asystole and were not observed ($p<0.001$). Mortality was high in patients whose time interval from collapse to the start of CPR duration was longer than 0-5 minutes ($p<0.001$). Age, male gender, number of comorbidities, out-of-hospital CA, asystole and no observed rhythm documented at the time of initiation of CPR, time interval from collapse to start of CPR and CPR duration above 5 minutes ($p<0.001$ for all), and non-cardiac etiology ($p=0.018$) were determined as independent predictors for mortality in logistic regression analysis.
Discussion: Evaluation of the factors affecting mortality in CA is important for the survival of CA patients.

Keywords
Cardiac Arrest, Emergency Department, Mortality

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Introduction

Cardiac arrest (CA), also known as cardiopulmonary arrest or circulatory arrest, is the cessation of adequate heart function and breathing [1]. CA is one of the most common causes of admission to the emergency department (ED), resulting in death if not immediately intervened and can occur in all age groups.

There are cardiac and non-cardiac causes in the etiology of CA [2]. Cardiac etiology of the CA accounts for approximately 2/3 of CA, where such patients often have underlying ischemic heart disease [3]. Non-cardiac etiology of CA causes include trauma, drug overdose, and sepsis, etc.

CA is evaluated in two groups: in-hospital CA (IHCA) and out-of-hospital CA (OHCA), depending on where the patient is located. ED is where IHCA cases mostly occur, and OHCA cases are also brought to ED for intervention. In general, OHCA is observed at a higher rate than IHCA, where approximately 200,000 IHCA and 350,000 OHCA cases occur annually in the United States [4].

Cardiopulmonary resuscitation (CPR) is the whole of applied methods to CA patients with the aim of returning to spontaneous circulation (ROSC).

Despite advances in CPR over the years, the mortality rate is still high in CA cases, and the survival rates are roughly 15-20% for IHCA and 5-10% for OHCA cases [3].

The present study aims to evaluate the factors contributing to mortality in CA cases in the ED.

Material and Methods

Patient population and study design

Following approval of the hospital's local ethics committee, electronic hospital records of CA patients between January 1, 2015, and January 1, 2020 were retrospectively analyzed. Patients who developed cardiac arrest during follow-up after being admitted to ED and underwent CPR were accepted as IHCA. Patients with CA outside the hospital, who were brought to the ED by ambulance after first response (including CPR) by emergency health services teams and continued to be treated there, were considered OHCA. Patients under the age of 18, patients who were accepted as dead, and patients with missing hospital records were excluded from the study. In addition, only the initial CPRs of the patients were evaluated.

The patients included in the study were evaluated in terms of their age, gender, location of CA (in-hospital, out-of-hospital), admission day (weekdays [Monday to Friday] and weekends [Saturday and Sunday]), admission during the day (morning [8 am to 4 pm], evening [4-11 pm], night [11 pm to 8 am]), comorbidity, number of comorbidities, etiology of CA, cardiac rhythm documented at the time of initiation of CPR (shockable rhythms [pulseless ventricular tachycardia /ventricular fibrillation], pulseless electrical activity/asystole, no observed), the time interval from collapse to start of CPR, CPR duration (minute), and mortality. In this study, alive was referred to as the ROSC. The ROSC was considered as a return of pulse and its maintenance for longer than 20 minutes.

Statistical analysis

Statistical analysis was performed using Statistical Package for the Social Sciences 22.0 (SPSS Inc. Chicago, IL). Mean standard deviation, median, minimum and maximum values were given in descriptive statistics for continuous data, and number and percentage values were given in discrete data. The Shapiro-Wilk test was used to examine the conformity of continuous data to normal distribution. The Chi-square was used to compare categorical variables in patients with and without dying. The t-test and Mann-Whitney U test were used to compare continuous data of the living and the dead. The power of the CPR duration to distinguish the dead was evaluated by the area under the receiver operating characteristic (ROC) Curve (AUC). The best cut-off value was calculated using Youden's index. Risk factors affecting mortality were analyzed using logistic regression analysis. $P<0.05$ was considered statistically significant.

Results

Gender analysis of the study group showed that out of 1932 patients, 1333 (69%) were male. The mean age of the patients was 50.15±16.20 years (range, min:18-max: 80). Seven hundred and thirty (37.8%) patients were 44 years of age or younger. The total number of patients who died in ED was 1582 (81.9%). Mortality was higher in males ($p<0.05$) and it was higher in the patients aged 45 to 64 years and those aged 75 years and over than in those aged 44 and below ($p<0.001$). CA occurred out-of-hospital in 1123 (58.1) patients. Mortality was higher in those with OHCA compared to IHCA ($p<0.001$) (Table1).

There was at least one comorbidity in 1260 (65.2%) of the CA patients, and the most common comorbidity was hypertension (HT) in 951 (49.2%) of the CA patients. Mortality was high in patients with diabetes mellitus (DM), ischemic heart disease, HT, chronic obstructive pulmonary disease, chronic kidney disease, chronic liver disease, malignancy, and other comorbidities, as well as patients with more than 3 or 4 comorbidities ($p<0.001$). Non-cardiac etiology was observed in 1257 (65%) of the CA patients, and mortality in non-cardiac CA was higher than those of cardiac CA ($p<0.001$). Sepsis, trauma, cancer, other and unknown etiologies were more common in deceased patients than in those who survived ($p<0.001$) (Table1).

Mortality was high in patients whose cardiac rhythm documented at the time of initiation of CPR was pulseless electrical activity asystole and was not observed ($p<0.001$).

Mortality was higher in patients whose time interval from collapse to start of CPR was more than 0-5 minutes ($p<0.001$)

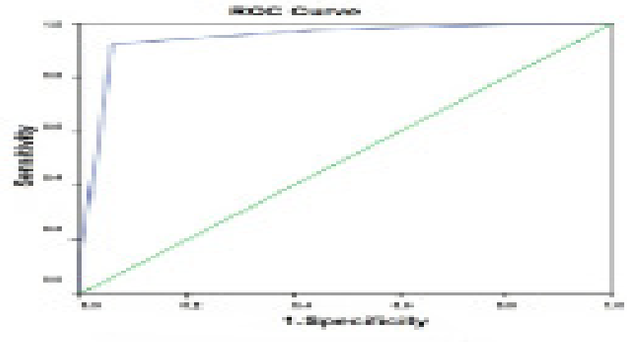

Figure 1. Graphic representation of Receiver Operating Characteristic Curve for cardiopulmonary resuscitation duration for mortality

Table 1. Clinical and demographic data of deceased and surviving patients

	Total n (%)	Alive n (%)	Dead n (%)	p
Gender				
Female	599 (31)	127 (36.3)	472 (29.8)	0.018
Male	1333 (69)	223 (63.7)	1110 (70.2)	
Age group (years)				
≤ 44	730 (37.8)	159 (45.4)	571 (36.1)	<0.001
45-64	674 (34.9)	151 (43.1)	523 (33.1)	
≥ 65	528 (27.3)	40 (11.4)	488 (30.8)	
Location of cardiac arrest				
In-hospital (ED)	809 (41.9)	309 (88.3)	500 (31.6)	<0.001
Out-of-hospital	1123 (58.1)	41 (11.7)	1082 (68.4)	
Admission day				
Weekday	988 (51.1)	176 (50.3)	812 (51.3)	0.727
Weekend	944 (48.9)	174 (49.7)	770 (48.7)	
Admission time during the day				
Morning (8 am to 4 pm)	890 (46.1)	161 (46)	729 (46.1)	0.984
Evening (4-11 pm)	402 (20.8)	74 (21.1)	328 (20.7)	
Night (11 pm to 8 am)	640 (33.1)	115 (32.9)	525 (33.2)	
Comorbidity				
Diabetes mellitus	670 (34.7)	32 (9.1)	638 (40.3)	<0.001
Ischemic heart disease	550 (28.5)	48 (13.7)	502 (31.7)	
Hypertension	951 (49.2)	62 (17.7)	889 (56.2)	
Chronic obstructive pulmonary disease	492 (25.5)	18 (5.1)	474 (30)	
Chronic kidney disease	234 (12.1)	13 (3.7)	153 (9.7)	
Chronic liver disease	205 (10.6)	6 (1.7)	228 (14.4)	
Malignancy	205 (10.6)	5 (1.4)	200 (12.6)	
Other	75 (3.9)	0 (0)	75 (4.7)	
Number of comorbidities				
One comorbidity	345 (27.7)	59 (51.3)	286 (25.3)	<0.001
Two comorbidities	240 (19.2)	56 (48.7)	184 (16.3)	
Three comorbidities	361 (28.9)	0 (0)	361 (31.9)	
≥Four comorbidities	301 (24.1)	0 (0)	301 (26.6)	
Etiology				
Cardiac	675 (34.9)	200 (57.1)	475 (30)	<0.001
Respiratory	150 (7.8)	68 (19.4)	82 (5.2)	
Sepsis	41 (2.1)	1 (0.3)	40 (2.5)	
Trauma	373 (19.3)	3 (0.9)	370 (23.4)	
Drug overdose	213 (11)	50 (14.3)	163 (10.3)	
Cancer*	196 (10.1)	8 (2.3)	188 (11.9)	
Other**	118 (6.1)	20 (5.7)	98 (6.2)	
Unknown	166 (8.6)	0 (0)	166 (10.5)	
Cardiac rhythm documented at the time of initiation of CPR				
Shockable rhythms	707 (36.6)	262 (74.9)	781 (49.4)	<0.001
Pulseless electrical activity/asystole	851 (44)	70 (20)	445 (28.1)	
No observed	374 (19.4)	18 (5.1)	356 (22.5)	
Time interval from collapse to start of CPR (minute)				
0-5	774 (40.1)	344 (98.3)	430 (27.2)	<0.001
6-10	923 (47.8)	6 (1.7)	917 (58)	
11-19	188 (9.7)	0 (0)	188 (11.9)	
≥ 20	47 (2.4)	0 (0)	47 (3)	

ED: Emergency department, CPR: Cardiopulmonary Resuscitation, cancer*: tumour-related causes and/or cancer treatment complications, other**: non-traumatic bleeding, epilepsy, electrolyte abnormalities, hypothermia

(Table 1).

The mean (mean± SD) age of the patients who died was 44.51±13.70 years, and the mean of age of the surviving patients was 51.40±16.45 (p<0.001). The mean (mean± SD) time of CPR was 12.40±6.06 and 31.98±7.16 for living and dead objects, respectively (p<0.001). The number of the comorbidities (mean± SD) was 0.52±0.86, and 1.99±1.68, respectively (p<0.001). AUC for CPR duration accounted for a significant proportion of variability in mortality (p<0.001), and the cut-off value was found as 17.5 minutes (Figure 1 and Table 2).

Age, gender (male), location (OHCA), number of comorbidities, cardiac rhythm documented at the time of initiation of CPR (pulseless electrical activity/asystole, no observed), time interval from collapse to start of CPR, and CPR duration above 5 minutes (p< 0.001 for all), and etiology (non-cardiac) (p=0.018) were determined as independent risk factors for predicting mortality in logistic regression analysis (Table 3).

After intensive care treatments, 41 (2.1%) patients were discharged from the hospital.

Discussion

CA is at the forefront of medical emergencies and is frequently observed in the ED. CA is a potentially reversible condition with successful CPR. The current mortality rate in CA remains critically high around the world, and it is therefore important to determine the factors affecting mortality.

In the current study, the mortality rate was 81.9%, and the survival rate to hospital discharge was 2.1%. The study by Sittichanbuncha et al. evaluated those who underwent CPR in ED, where 50.6% of patients died, and the survival rate at discharge was 11.1% [5]. In another study, the survival rate of patients to discharge from the hospital was 9.9% [6]. In the literature, the mean age of CA patients is approximately 56-75 years [3,7-10]. In the study by Alzahrani et al., three age groups were present and studied: under 45 years of age (22.8%), between 45-65 years of age (40.6%), and over 65 years of age (36.6%) [11]. The current study included patients aged 44 years and younger (37.8%), between 45-65 years (34.9%), 65 years and older (27.3%). Although the mean age of patients in the current study was 50.15, more than 1/3 of the patients were aged 44 years or younger.

It is known and expected that elderly patients have an increased risk of CA due to aging. However, our study showed that the incidence of CA increased towards the younger age group. Some studies suggest that age is not associated with survival, while one study suggests that advancing age is a poor prognostic factor [8,12-14]. The current study's findings indicated that age is a contributing factor to mortality in CA patients. The results of our study suggest that age is a factor contributing to mortality in CA patients.

In the study by Pandian et al., there was no relationship between gender and mortality [6]. However, in our study, the mortality rate was higher in male patients (p<0.05). It is known that females have a lower incidence of CA than males due to various reasons, such as physiological differences between males and females and the protective effects of estrogen on the heart in females. This difference in mortality rate might be explained

Table 2. Receiver Operating Characteristic analysis results of cardiopulmonary resuscitation duration for mortality.

	Area Under Curve	Standard Error	95 % CI		p	Treshold
			Lower Bound	Upper Bound		
Cardiopulmonary Resuscitation duration (minute)	0.947	0.007	0.933	0.961	<0.001	>17.5

Table 3. Logistic regression analysis of factors affecting mortality

Parameter	Odds Ratio	95% CI	p
Age	1.027	1.019-1.034	<0.001
Gender (male)	1.339	2.451-3.940	<0.001
Location (OHCA)	16.309	11.579-22.973	<0.001
Number of comorbidities	2.208	1.961-2.487	<0.001
Etiology (non-cardiac)	3.107	1.050-1.708	0.018
Cardiac rhythm documented at the time of initiation of CPR (pulseless electrical activity/asystole, no observed)	7.607	5.835-9.917	<0.001
CRP duration (minute)	1.295	1.264-1.327	<0.001
Time interval from collapse to start of CPR>5 minute	153.6	68.012-346.893	<0.001

OHCA: out-of-hospital cardiac arrest, CPR: Cardiopulmonary Resuscitation

by the fact that most of the patients in the current study were males.

In this study, mortality was higher in OHCA than in IHCA. Contrary to OHCA, deterioration of physiological parameters in the majority of patients in IHCA can be a warning in terms of CA that may occur in these patients. Therefore, IHCA patients are relatively predictable and preventable.

In the study by Pandian et al., CA was observed more frequently during morning shift hours compared to evening and night hours [6], while there was no significant time difference in the study by Alzahraniet et al. [11]. In a large-scale multicenter study, an increase in OHCA was found between 8:00 and 10:59 in all age groups. They stated that this difference observed in the morning was caused by physiological changes, but was not significantly correlated with the mortality of admitted patients [15]. In this study, morning time admission was more common in CA; however, the results did not conclude a significant relationship between time of admission and mortality in CA patients.

Cardiovascular risks in mid-life cardiac CA, smoking, and antihypertensive treatment in non-cardiac CA are among the risk factors [3]. In the study by Pandian et al., 88.9% of patients had at least one comorbidity, and 29.1% had two or more comorbidities, with DM (34.3%) and HT (32.7%) being the most common comorbidities [6]. In a similar study conducted with CA in Turkey, the most common comorbidities identified in CA patients were HT (82%) and DM (67%) [9].

As the number of comorbidities increases in CA patients, the probability of survival of patients decreases. In a study, the survival rate for CA patients was 64% for patients with one or less comorbid disease and 9.6% for patients with two comorbidities, and all those with more than two comorbidities died [16]. In another study, a 20% survival rate was observed in those without comorbidity and 6% in those with more than two comorbidities [8]. Similarly, the survival rate decreased as the number of comorbidities increased in our study. In addition, all patients with three or more comorbidities could not be saved and died.

CA patients with cardiac etiology are most common among both in-hospital and out-of-hospital patients. In addition, survival in CA patients with cardiac etiology is higher than in non-cardiac etiology. As it is known, CA due to drug overdose in young adults has recently constituted an important part of OHCA [8]. CA due to drug overdose constitutes 11% of the overall CA in this study. Therefore, drug overdose should be considered in etiology, especially in young adult CA patients who are admitted to ED. The survival rate in these patients ranges from 3% to 19% [17]. Traumatic CA accounted for 19.3% in our study, which might be due to the the fact that the hospital in which the study was held was a tertiary-level trauma center hospital in the region. The prognosis in traumatic CA is very poor and; some of these patients die before reaching the hospital. In the study by Xue et al., only 2.1% of traumatic CA patients survived within 24 hours, and none were discharged [18]. In the present study, there was a 0.9% survival rate in patients with traumatic CA. Furthermore, all patients with unknown etiology died in the ED, and all of these patients were considered as OHCA.

In the study by Ohlsson et al., 26.2%of the patients had ventricular fibrillation or ventricular tachycardia, 59.5% had asystole, and 14.3% had pulseless electrical activity, regardless of where CA occurred [3]. According to Pandian et al.'s study, 76% of CA patients had pulseless electrical activity/asystole, 8% had shockable rhythms, and 16% had no observed rhythm documented at the time of initiation of CPR [6]. Similar to these studies, the most common cardiac rhythm in this study was pulseless electrical activity/asystole (44%). Hence it can be concluded that the effect of rhythm documented at the time of initiation of CPR on mortality is significant in CA. The mortality rate in patients with cardiac rhythm documented at the time of initiation of CPR, ventricular fibrillation, and ventricular tachycardia is lower than those present with asystole and pulseless electrical activity [10].

CPR should be started as soon as possible after CA, in both IHCA and OHCA patients. The study of Vancini et al. found that the median CPR duration was 17 minutes, and the mortality was higher in those with longer, more prolonged CPR in ED [10]. It was reported in a study that CPR duration of 21 minutes or more was associated with increased mortality in IHCA [7]. In the large multicenter study conducted with IHCA, the median resuscitation time CPR duration was found to be 12 minutes in those with a return of spontaneous circulation, while it was 20 minutes in non-survivors [19]. In the current study, the median CPR duration was 10 minutes for those alive and 30 minutes for those who died.

Although this is a single-center study, the high number of patient populations is a valuable aspect. However, one of the main limitations of the current study is its retrospective design. In addition, the data on long-term follow-up of discharged

patients were not available and not evaluated by this study.

Conclusion

CA patients are one of the most common conditions in ED. Our results showed that the mortality rate among CA patients was very high. The age, gender, localization of CA, comorbidity, number of comorbidities, etiology, cardiac rhythm documented at the initiation of CPR, the time interval from collapse to start of CPR, and CPR duration plays a role in mortality in CA cases.

Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and human rights statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.

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Conflict of interest

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